

Synergistically acting herbicidal mixtures

Description

5 The present invention relates to a synergistic herbicidal mixture comprising

A) a compound selected from the group consisting of imidazolinones, sulfonylureas and sulfonamides, including their respective isomers as well as their respective environmentally compatible salts or esters or amides or other derivatives;

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and

B) at least one herbicidal compound of the group of chloro acetamides, oxyacetamides and tetrazolinones as well as quinmerac including their respective isomers as well as their respective environmentally compatible salts or esters or amides or other derivatives

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and, if desired,

20 C) at least one herbicidal compound selected from the group consisting of clomazone, atrazin, dichlormid, benoxacor, LAB-145138, MG-191, MON-13900, cyometrinil, oxabetrinil, fluxofenim, flurazole, naphthalic acid anhydride, fenchlorim, fenchlorazol, mefenpyr, cloquintocet (including its hydrate(s)), 1-ethyl-4-hydroxy-3-(1H-tetrazol-5-yl)-1H-quinolin-2-one, 4-carboxymethyl-chroman-4-carboxylic acid, N-(2-methoxy-benzoyl)-4-(3-methyl-ureido)-benzenesulfonamide, (3-oxo-isothiochroman-4-ylidenemethoxy)-acetic acid methyl ester including their respective isomers as well as their respective environmentally compatible salts or esters or amides or other derivatives.

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30 The invention furthermore relates to herbicidal compositions comprising a herbicidally active amount of a synergistic herbicidal mixture as defined above and at least one liquid and/or solid carrier and, if desired, at least one further additive.

Moreover, the invention relates to a method of controlling undesirable vegetation by using above defined synergistic herbicidal mixture.

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In crop protection products, it is always desirable to increase the specific activity and/or selectivity of an active ingredient and the reliability of action.

40 However, the activity and/or the selectivity of herbicides depends on a large number of factors e.g. type of the herbicide, amount of the herbicide, formulation of the herbicide, the type of weed, the combination of crop and weed, climate, soil. etc.

In many cases herbicides have an effect against a broad spectrum of weeds, however do not fight a certain type of other weeds, which is also present in the crop cultures to be protected.

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Sometimes these obstacles can be overcome by using just bigger amounts of herbicide, however this is economically disadvantageous and may also reduce the selectivity of the herbicide, in other words may lead to damage of the crop to be protected.

10 It is a general desire in the application of agrochemicals to reduce their amount on one side and to broaden their ability to fight different weeds - which grow in certain crop cultures - without damaging the crop cultures on the other side.

15 This desire may be satisfied by combination of different herbicides having a different activity profile versus undesired weeds.

20 However, because of the huge number of herbicide active ingredients known in the art and the many factors which influence the activity and selectivity of herbicides it is virtually impossible to create the appropriate mixture just by doing some mixture experiments.

Therefore it is always a challenge to find an appropriate herbicide or herbicide mixture which fights a certain group of weeds in a certain crop culture.

25 WO 00/08938 A1 (now EP 1 104 241 B1, Bayer CropScience) describes the use of herbicide combinations for fighting weeds in herbicide resistant oilseed rape. Certain herbicidal compositions as such are also described. Respective herbicides are to be selected from four different groups and are to be combined with herbicides to be selected from five other groups. The gist of WO 00/08938 A1 is the combination of glyphosate or glufosinate with other co herbicides.

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The herbicide combinations of the instant application as well as their use as described in the instant application are not disclosed in WO 00/08938 A1.

35 It is an object of the present invention to increase the activity and/or selectivity of herbicides against undesirable harmful plants, in particular in certain crops (e.g. oilseed rape, canola (brassica napus)), without damaging these crops.

40 We have found that this object is achieved by the mixtures defined at the outset. We have furthermore found herbicidal compositions which comprise these mixtures, and methods of controlling undesirable vegetation.

The mixtures according to the invention show a synergistic effect; the compatibility of the herbicidally active compounds of components A), B) and, if desired C) for certain crop plants is generally retained.

- 5 The compounds which are embraced by component A) are the following.

Herbicideal imidazolinones are known e.g. from C.D.S. Tomlin, "The Pesticide Manual", 13<sup>th</sup> Edition, BCPC (2003), Index 5, 1337-1344 and [http://www.hclrss.demon.co.uk/index\\_cn\\_frame.html](http://www.hclrss.demon.co.uk/index_cn_frame.html).

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The term "Imidazolinones" shall mean herein the compounds as mentioned above, as well as their a) salts, e.g. salts of alkaline or earth alkaline metals or ammonium or organoammonium salts, for instance, sodium, potassium, ammonium, isopropyl ammonium etc.; b) respective isomers, e.g. stereo isomers such as the respective enantiomers, in particular the respective R- or S-enantiomers (including salts, ester, amides), c) respective esters, e.g. carboxylic acid C1-C8-(branched or non-branched) alkyl esters, such as methylesters, ethylesters, isopropyl esters, d) respective amides, e.g. carboxylic acid amides or carboxylic acid C1-C8-(branched or non-branched) mono or di alkyl amides, such as dimethylamides, diethylamides, diisopropyl amides or e) any other derivative which contains the above imidazolinone structures as structural moiety.

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Very suitable Imidazolinones are the R-isomers, e.g. R-imazamethabenz-methyl, R-imazamox, R-imazapic, R-imazapyr, R-imazaquin, R-imazethapyr, in particular R-imazamox. These compounds are known e.g. from US 5,973,154 B (American Cyanamid Company) and US 6,339,158 B1 (American Cyanamid Company).

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Sulfonylureas are known from C.D.S. Tomlin, "The Pesticide Manual", 13<sup>th</sup> Edition, BCPC (2003), Index 5, 1337-1344 and [http://www.hclrss.demon.co.uk/index\\_cn\\_frame.html](http://www.hclrss.demon.co.uk/index_cn_frame.html)

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Examples of suitable Sulfonylureas are nicosulfuron, tritosulfuron, mesosulfuron, cyclo-sulfamuron, rimsulfuron, foramsulfuron.

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The term "Sulfonylureas" shall mean herein the compounds as mentioned above, as well as their a) salts, e.g. salts of alkaline or earth alkaline metals or ammonium or organoammonium salts, for instance, sodium, potassium, ammonium, isopropyl ammonium etc.; b) respective isomers, e.g. stereo isomers such as the respective enantiomers, c) respective esters, e.g. C1-C8-(branched or non-branched) alkyl esters, such as methylesters, ethylesters, isopropyl esters, d) respective amides, e.g. amides or C1-C8-(branched or non-branched) mono or di alkyl amides, such as dimethylamides, diethylamides, diisopropyl amides.

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Very suitable Sulfonylureas are cross spectrum sulfonylureas for example nicosulfuron, mesosulfuron, rimsulfuron or foramsulfuron.

5 Examples of suitable sulfonamides (also known as "triazolopyrimidines" or "sulfonamide herbicides") are known from C.D.S. Tomlin, "The Pesticide Manual", 13<sup>th</sup> Edition, BCPC (2003), Index 5, 1337-1344, WO 02/36596 A (Dow Agrosiences LLC) and [http://www.hclrss.demon.co.uk/index\\_cn\\_frame.html](http://www.hclrss.demon.co.uk/index_cn_frame.html)

10 The term "Sulfonamides" shall mean herein the compounds as mentioned above as well as their a) salts, e.g. salts of alkaline or earth alkaline metals or ammonium or organoammonium salts, for instance, sodium, potassium, ammonium, isopropyl ammonium etc.; b) their respective isomers, e.g. stereo isomers such as the respective enantiomers, c) respective esters, e.g. C1-C8-(branched or non-branched) alkyl esters, such as methylesters, ethylesters, isopropyl esters, d) respective amides, e.g. amides or  
15 C1-C8-(branched or non-branched) mono or di alkyl amides, such as dimethylamides, diethylamides, di isopropyl amides.

Very suitable Sulfonamides are florasulam, flumetsulam, metosulam, penoxulam, cloransulam-methyl, diclosulam and N-(5,7-dimethoxy[1,2,4]triazolo[1,5-a]pyrimidin-2-  
20 yl)-2-methoxy-4-(trifluoromethyl)- 3-pyridinesulfonamide (the latter disclosed in Research Disclosure July 2002, 1230-1231 and WO 02/36596 A (Dow Agrosiences LLC)), in particular florasulam, penoxulam and N-(5,7-dimethoxy[1,2,4]triazolo[1,5-a]pyrimidin-2-yl)-2-methoxy-4-(trifluoromethyl)- 3-pyridinesulfonamide.

25 The compounds which are embraced by component B) are the following.

Chloro acetamides, oxyacetamides and tetrazolinones as described in C.D.S. Tomlin, "The Pesticide Manual", 13<sup>th</sup> Edition, BCPC (2003), Index 5, 1337-1344 and [http://www.hclrss.demon.co.uk/index\\_cn\\_frame.html](http://www.hclrss.demon.co.uk/index_cn_frame.html).  
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The term "Chloro Acetamides" shall mean herein the compounds as such as well as a) their salts, e.g. salts of alkaline or earth alkaline metals or ammonium or organoammonium salts, for instance, sodium, potassium, ammonium, isopropyl ammonium etc. or b) their respective isomers, e.g. stereo isomers such as the respective enantiomers.  
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Suitable Chloro Acetamides are metazachlor, metolachlor, "S-metolachlor", acetochlor, dimethachlor, alachlor and dimethenamid and dimethenamid-P and pethoxamid.

40 Metazachlor herein shall mean 2-Chloro-(2',6'-dimethyl-N-pyrazol-1-yl-methyl)-acetamid in all of its crystal modifications, in particular the monoclinic Metazachlor which is described in EP 0 411 408 A (BASF Aktiengesellschaft).

Metolachlor herein shall mean the racemic mixture of the compound CAS RN [51218-45-2] and the compound S-metolachlor and any mixture of S-isomer of metolachlor (CAS RN [87392-12-9]) and R-isomer of metolachlor (CAS RN [178961-20-1]).

- 5 Dimethenamid herein shall mean the compounds listed in C.D.S. Tomlin, "The Pesticide Manual", 13<sup>th</sup> Edition, BCPC (2003), Index 5, 1337-1344 and [http://www.hclrss.demon.co.uk/index\\_cn\\_frame.html](http://www.hclrss.demon.co.uk/index_cn_frame.html), in particular the S-isomer (dimethenamid-P).
- 10 For clarity sake the terms Metazachlor, Metolachlor, Acetochlor and Dimetenamid shall include herein the compounds as mentioned above as well as their salts, e.g. salts of alkaline or earth alkaline metals or ammonium or organoammonium salts, for instance, sodium, pottasium, magnesium, ammonium, isopropyl ammonium etc.
- 15 Preferred component B) comprises Metazachlor, in particular monoclinic Metazachlor, Dimethenamid, Dimethenamid-P, Metolachlor and Quinmerac.

A very preferred component B) is Metazachlor, in particular monoclinic Metazachlor.

- 20 Further componets C) may be selected from the group consisting of clomazone, , atrazine (see C.D.S. Tomlin, "The Pesticide Manual", 13<sup>th</sup> Edition, BCPC (2003), Index 5, 1337-1344 and [http://www.hclrss.demon.co.uk/index\\_cn\\_frame.html](http://www.hclrss.demon.co.uk/index_cn_frame.html)) and the following compounds which usually function as "safeners", dichlormid, benoxacor, LAB-145138, MG-191, MON-13900, cyometrinil, oxabetrinil, fluxofenim, flurazole,
- 25 naphtalicacidanhydride, fenchlorim, fenchlorazol, cloquintocet (including its esters and hydrate(s)), as described in "Herbizide [Herbicides]", Hock, Fedtke, Schmidt, 1st edition, Thieme 1995 (s. "Dichlormid" p.263, "Benoxacor" p.263, "LAB-145138" p.263, "MG-191" p.263, "MON-13900" p.263, "Cyometrinil" p.265, "Oxabetrinil" p.265, "Fluxofenim" p.265, "Flurazole" p.265, "Naphtalicacidanhydride" p.265, "Fenchlorim"
- 30 p.266, "Fenchlorazol" p.266 Isoxadifen, "Cloquintocet" p.266], or C.D.S. Tomlin, "The Pesticide Manual", 13<sup>th</sup> Edition, BCPC (2003), Index 5, 1337-1344 and [http://www.hclrss.demon.co.uk/index\\_cn\\_frame.html](http://www.hclrss.demon.co.uk/index_cn_frame.html) e.g. mefenpyr-diethyl, isoxadifen, 1-ethyl-4-hydroxy-3-(1*H*-tetrazol-5-yl)-1*H*-quinolin-2-one, 4-carboxymethyl-chroman-4-carboxylic acid, *N*-(2-methoxy-benzoyl)-4-(3-methyl-ureido)-benzenesulfonamide, (3-
- 35 oxo-isothiochroman-4-ylidenemethoxy)-acetic acid methyl ester, all of these including their respective isomers as well as their respective environmentally compatible salts or esters or amides or other derivatives.

- Preferred other components C) are clomazone, , atrazin and the safeners cloquintocet
- 40 (including its esters and hydrate(s)).



Preferred herbicidal mixtures or combinations according to the invention are the following

- (M1) Imazamox + Metazachlor (monoclinic or triclinic or any mixture of those)
- 5 (M1-1) R-Imazamox + Metazachlor which contains at least 90 weight-% of the monoclinic form
- (M1-2) R-Imazamox + Metazachlor (monoclinic or triclinic or any mixture of those)
- (M2) Imazamox + Metolachlor (racemic, S-isomer, or any mixture of R- and S-isomer)
- 10 (M2-1) R-Imazamox + Metolachlor (racemic, S-isomer, or any mixture of R- and S-isomer)
- (M3) Imazamox + Dimethenamid (racemic or S-isomer)
- (M3-1) R-Imazamox + Dimethenamid (in particular the S-isomer)
- 15 (M4) Imazamox + Metazachlor (monoclinic or triclinic or any mixture of those) + clomazone
- (M4-1) R-Imazamox + Metazachlor which contains at least 90 weight-% of the monoclinic form + clomazone
- 20 (M5) Imazamox + Metazachlor (monoclinic or triclinic or any mixture of those) + quinmerac
- (M5-1) R-Imazamox + Metazachlor which contains at least 90 weight-% of the monoclinic form + quinmerac
- 25 (M6) Imazamox + Metolachlor (including S-Metolachlor) + atrazin
- (M7) Imazamox + Flufenacet
- 30 (M8) Imazamox + Fentrazamide

Particular preferred herbicidal mixtures according to the invention are the following:

- 35 M1, M1-1, M1-2, M4 and M4-1, M5 and M5-1, M6, M7 and M8.

The present invention also extends to herbicidal compositions which comprise a herbicidally active amount of a synergistic herbicidal mixture (comprising components A), B) and, if desired, C) as described above), at least one liquid and/or solid carrier and, if desired, at least one further additive, for example a surfactant, adjuvant or others.

40 The herbicidal compositions and synergistic herbicidal mixtures according to the invention can effect very good control of broad-leaved weeds and grass weeds in many

crops for example maize, cereals (for example wheat), brassica napus (canola, oilseed rape), sunflower, legumes, sugar cane, and soya without damaging the crop plants, an effect observed especially even at low rates of application.

5 Taking into consideration the variety of application method in question, the herbicidal compositions and synergistic herbicidal mixtures according to the invention can additionally be employed in a further number of crop plants for eliminating undesirable plants.

10 The herbicidal compositions and synergistic herbicidal mixtures according to the invention can preferably be used in crops which tolerate and/or are resistant to the action of ALS herbicides, preferably those ALS herbicides according to the invention. The resistance and or tolerance to said herbicides may be achieved by conventional breeding and/or by genetic engineering methods.

15 Crops which are tolerant to herbicides (e.g. tolerant to imidazolinone herbicides) are known for example from EP 0 154 204 A (MGI Pharma Inc.). Such crops are for example marketed by BASF under the trade name CLEARFIELD. Examples for such crops are maize, brassica napus (canola, oilseed rape), sunflower, rice, lentils and wheat.

20 Most preferable herbicide tolerant or herbicide resistant crops according to the invention is oilseed rape, canola (brassica napus).

25 The herbicidal mixtures or compositions according to the invention, for example the mixtures containing Imidazolinones as sole component A), preferably the mixtures of Imidazolinones and Chloro Acetamides, very preferably mixtures or compositions comprising Imazamox and Metazachlor or Imazamox and at least one other herbicide of the groups B) and/or C) (for example those as disclosed under M1, M1-1, M1-2, M2, M2-1, M3, M3-1, M4, M4-1, M5 and M5-1, M6, M7 and M8) and in particular mixtures  
30 of Imazamox and Chloro Acetamides (for example those as disclosed under M1, M1-1, M1-2, M2, M2-1, M3, M3-1, M4, M4-1, M5 and M5-1 are very suitable for fighting or controlling a broad spectrum of grasses and broadleaf weeds which are accompanying in general the abovementioned crops, e.g. in particular brassica napus (oil seed rape, canola).

35 Very preferably the weeds in ALS-herbicide resistant or tolerant brassica napus (oilseed rape, canola) are fought by the herbicidal mixtures or compositions according to the invention - for example the mixtures containing Imidazolinones as sole component A), preferably the mixtures of Imidazolinones and Chloro Acetamides, very  
40 preferably mixtures of Imazamox and Chloro Acetamides (for example those as disclosed under M1, M1-1, M1-2, M2, M2-1, M3, M3-1, M4, M4-1, M5, M5-1 above)

and in particular those mixtures or compositions comprising Imazamox and Metazachlor. Those weeds include but are not limited to the following plant species:

5 Alopecurus myosuroides; Apera spica-venti; Avena spec.; Brassica spec.; Capsella bursa-pastoris; Galium aparine; Lamium spec.; Raphanus spec.; Sinapis spec.; Sisymbrium officinale; Stellaria media; Thlaspi arvense. Veronica spec.

10 Very suitable ALS resistant or tolerant crop / to be controlled weed / herbicide mixture (composition) combinations are the following. Controlled weeds include but are not limited to the listed plant species.

	<u>ALS tolerant crop</u>	<u>Herbicide Mixture</u>	<u>Weed (Latin name)</u>
15	Canola	Imazamox+Metazachlor	Agropyron repens Geranium pussilum Sinapis alba Sisymbrium officinale
20	Canola	Imazamox+Metazachlor +quinmerac	Agropyron repens Galium aparine Geranium pussilum Sinapis alba Sisymbrium officinale
25	Canola	Imazamox+Metazachlor +clomazone	Agropyron repens Galium aparine Geranium pussilum Sinapis alba Sisymbrium officinale
30	Corn, sunflower	Imazamox+(Dimethenamid or Dimethenamid-p)	Echinochloa spec. Setaria spec. Digitaria spec.
35	Corn	Imazamox+(Dimethenamid or Dimethenamid-p)+atrazin	Echinochloa spec. Setaria spec. Digitaria spec Chenopodium spec. Polygonum spec.
40	Corn, sunflower	Imazamox+(Metolachlor or S-Metolachlor)	Echinochloa spec. Setaria spec.



			Digitaria spec Chenopodium spec. Polygonum spec.
5	Corn	Imazamox+(Metolachlor or S-Metolachlor)+atrazin	Echinochloa spec. Setaria spec. Digitaria spec Chenopodium spec. Polygonum spec
10	Wheat	Imazamox+Flufenacet	Alopecurus spec. Apera spec. Galium spec.
15	Rice	Imazamox+Fentrazamide	Oryza rupifogon Echinochloa spec.

20 The mixtures according to the invention, or the herbicidal compositions comprising them, can be employed, for example, in the form of directly sprayable aqueous solutions, powders, suspensions, also highly-concentrated aqueous, oily or other suspensions or dispersions, emulsions, oil dispersions, pastes, dusts, materials for spreading or granules, by means of spraying, atomizing, dusting, spreading or pouring.

25 The use forms depend on the intended purposes; in any case, they should guarantee the finest possible distribution of the active ingredients according to the invention.

30 Suitable inert additives (auxiliaries) are mineral oil fractions of medium to high boiling point such as kerosene and diesel oil, furthermore coal tar oils and oils of vegetable or animal origin, aliphatic, cyclic and aromatic hydrocarbons, e.g. paraffins, tetrahydronaphthalene, alkylated naphthalenes and their derivatives, alkylated benzenes and their derivatives, alcohols such as methanol, ethanol, propanol, butanol and cyclohexanol, ketones such as cyclohexanone, strongly polar solvents, such as N-methylpyrrolidone and water.

35 Aqueous use forms can be prepared from emulsion concentrates, suspensions, pastes, wettable powders or water-dispersible granules by adding water. To prepare emulsions, pastes or oil dispersions, the substances, as such or dissolved in an oil or solvent, can be homogenized in water by means of wetting agent, tackifier, dispersant or emulsifier. However, it is also possible to prepare concentrates composed of active  
40 substance, wetting agent, tackifier, dispersant or emulsifier and, if appropriate, solvent or oil, and these concentrates are suitable for dilution with water.

Suitable surfactants are the alkali metal, alkaline earth metal and ammonium salts of aromatic sulfonic acids, e.g. ligno-, phenol-, naphthalene- and dibutyl-naphthalenesulfonic acid, and of fatty acids, of alkyl- and alkylaryl sulfonates, of alkyl sulfates, lauryl ether sulfates and fatty alcohol sulfates, and salts of sulfated hexa-, hepta- and octa-decanols, and of fatty alcohol glycol ether, condensates of sulfonated naphthalene and its derivatives with formaldehyde, condensates of naphthalene, or of the naphthalene-sulfonic acids, with phenol and formaldehyde, polyoxyethylene octylphenyl ether, ethoxylated isooctyl-, octyl- or nonylphenol, alkylphenyl and tributylphenyl polyglycol ether, alkylaryl polyether alcohols, isotridecyl alcohol, fatty alcohol/ethylene oxide condensates, ethoxylated castor oil, polyoxyethylene alkyl ethers or polyoxypropylene alkyl ethers, lauryl alcohol polyglycol ether acetate, sorbitol esters, lignin-sulfite waste liquors or methylcellulose.

Powders, materials for spreading and dusts can be prepared by mixing or concomitantly grinding the synergistic herbicidal mixture or the individual active ingredients with a solid carrier.

Granules, e.g. coated granules, impregnated granules and homogeneous granules, can be prepared by binding the active ingredients to solid carriers. Solid carriers are mineral earths such as silicas, silica gels, silicates, talc, kaolin, limestone, lime, chalk, bole, loess, clay, dolomite, diatomaceous earth, calcium sulfate, magnesium sulfate, magnesium oxide, ground synthetic material, fertilizers such as ammonium sulfate, ammonium phosphate, ammonium nitrate, ureas and products of vegetable origin such as cereal meal, tree bark meal, wood meal and nutshell meal, cellulose powders or other solid carriers.

The concentrations of the mixtures according to the invention in the ready-to-use products can be varied within wide ranges. In general, the formulations comprise from 0.01 to 95% by weight, preferably 0.5 to 90% by weight, of the mixture according to the invention.

The components A) and B) and, if desired, C) can be formulated jointly, but also separately, and/or applied to the plants, their environment and/or seeds jointly or separately. It is preferable to apply the active ingredients simultaneously. However, it is also possible to apply them separately.

Moreover, it may be advantageous to apply the herbicidal compositions and synergistic herbicidal mixtures according to the invention, jointly or separately, with additional other crop protection agents, for example with pesticides or agents for controlling phytopathogenic fungi or bacteria. Also of interest is the miscibility with mineral salt solutions which are employed for treating nutritional and trace element deficiencies. Non-phytotoxic oils and oil concentrates can also be added.

The mixtures according to the invention and the herbicidal compositions can be applied pre- or post-emergence. It is advantageous to apply the mixtures according to the invention post emergent when the crop has in general 1 to 6 leaves.

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If the active ingredients are less well tolerated by certain crop plants, application techniques may be used in which the herbicidal compositions are sprayed, with the aid of the spray apparatus, in such a way that they come into as little contact, if any, with the leaves of the sensitive crop plants while reaching the leaves of undesirable plants which grow underneath, or the bare soil (post-directed, lay-by).

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In the case of a post-emergence treatment of the plants, the herbicidal mixtures or compositions according to the invention are preferably applied by foliar application. Application may be effected, for example, by usual spraying techniques with water as the carrier, using amounts of spray mixture of approx. 15 to 1000 l/ha. The mixtures or compositions may also be applied by the so-called "low-volume" and "ultra-low-volume" methods, or in the form of so-called granules.

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As a rule, the synergistic herbicidal mixtures comprise components A), B) and, if desired, C) in such weight ratios that the synergistic effect takes place.

The ratios of component A) and B) in the mixture in general range from 1:0.001 to 1:500, preferably from 1:0.01 to 1:100, particularly preferably from 1:0.1 to 1:50.

The ratios of components A) and C) in the mixture in general range from 1:0.002 to 1:800, preferably from 1:0.003 to 1:160, particularly preferably from 1:0.02 to 1:160.

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The rate of application of pure synergistic herbicidal mixture, i.e. without formulation auxiliaries, amounts in general to 0.1 to 5000 g/ha, preferably 1 to 3000 g/ha, in particular 5 to 2500 g/ha, of active substance (a.s.), depending on the intended aim, the season, the target plants and growth stage.

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The cumulated rate (sum of the amounts of all active ingredients of the respective group A)) of application of the component(s) A) is usually 5 to 75 g/ha of active substance (a.s.).

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The rate of application of the Imidazolinones is usually 0.1 to 200 g/ha, as a rule 1 to 150 g/ha, preferably 5 to 100 g/ha, of active substance (a.s.).

In particular the rate of application of Imazamox is usually 0.1 to 200 g/ha, as a rule, 1 to 100 g/ha, preferably 2 to 100 g/ha, of active substance (a.s.).

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The rate of application of the Sulfonylureas or Sulfonamides is usually 0.1 to 200 g/ha, as a rule 1 to 100 g/ha, preferably 2 to 100 g/ha, of active substance (a.s.).

5 The rate of application of component B) is usually 0.1 to 5000 g/ha, as a rule 1 to 4000 g/ha , preferably 5 to 3000 g/ha, of active substance (a.s.)

In particular the rate of application of Chloro Acetamide - e.g. Metazachlor, Metolachlor, Dimethenamid - is usually 50 to 5000 g/ha, as a rule 75 to 3000 g/ha, preferably 100 to 2000 g/ha, of active substance (a.s.).

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The preferred application rates of the active ingredients of the optional component C) are compiled in the following table.

Active ingredient C	Rate of application (g/ha)
Dichlormid	100-600
Benoxacor	10-200
LAB 145138	50-500
MG-191	200-1000
MON-13900 (Furilazole)	10-300
Naphtalicacidanhydride	300-1000
Fenchlorim	20-500
Fenchlorazol	5-100
Mefenpyr-diethyl	5-100
Isoxadifen-ethyl	1-100
Cloquintocet-mexyl	1-50
AD 67	50-500
R 29148	50-500

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The herbicidal compositions and synergistic herbicidal mixtures according to the invention are very useful to control a broad spectrum of grass and broadleaf weeds.

This usually leads to cleaner fields and higher purity of the harvested commodity as well as to higher yields of the respective crop, in particular brassica napus (oilseed rape, canola).

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In particular brassica napus (oilseed rape, canola) seeds coming from fields treated with the herbicidal compositions and synergistic herbicidal mixtures according to the invention usually have higher seed purity. Based on current knowledge this may be due to the removal of unwanted brassica species.

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A further advantage of the instant invention is the general reduction of tillage in the respective fields which – based on current knowledge - usually leads to less loss of soil by e.g. wind.

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#### Examples

The mixtures according to the invention were applied pre- or post-emergence (foliar treatment). The herbicidal compounds of component A), B) and, if desired, of component C) were applied in the formulation in which they are present as commercially available product, e.g. Beyond or PULSAR 40 which is a Trademark of BASF and which is a liquid formulation containing imazamox as active ingredient; Raptor which is a trademark of BASF and which is imazamox formulated as 70 % WG or as liquid formulation; Butisan S which is a trademark of BASF and which is 500 g/l metazachlor formulated as SC; Outlook which is a dimethenamid P containing formulation.

The herbicidally active compounds of components A), B) were applied in succession or jointly, in the latter case in some cases as a tank mix and in some cases as a readymix, in the form of emulsions, aqueous solutions or suspensions, the vehicle being water (200 – 400 l/ha). In the case of the field trials, application was effected with the aid of a mobile plot sprayer.

The test period is specified in the respective tables.

Damage by the herbicidal compositions was evaluated with reference to a scale of 0% to 100% in comparison with untreated control plots. 0 means no damage and 100 means complete destruction of the plants (cf. numbers in the column "Control" in the following tables).

The following examples will demonstrate the action of the herbicidal compositions which can be used according to the invention, without excluding the possibility of other uses.

In these examples, the value E at which only an additive effect of the individual active ingredients is to be expected was calculated by the method of S. R. Colby (Calculating synergistic and antagonistic responses of herbicide combinations, Weeds 15, 20 pp (1967)).



This was done using the formula

$$E = X + Y - \frac{XY}{100}$$

5 where

X = Percentage of the herbicidal action of component A) at an application rate of a;

Y = Percentage of the herbicidal action of component B) at an application rate of b;

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E = expected herbicidal action of component A) + B) at rates of application a + b (in %).

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If the value observed exceeds the value E calculated in accordance with Colby's formula, then synergism is present.

For example the values in the columns "Control" in the following tables all show synergism.

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The herbicidal mixtures according to the invention exert a greater herbicidal action than would have been expected according to Colby on the basis of the observed effects of the individual components when used alone.

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Further abbreviations in the following tables and their meaning:

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a.i.	active ingredient (e.g. imazamox)
GS	Growth Stage (according to "Compendium of Growth Stage Identification Keys for Mono- and Dicotyledonous Plants – Extended BBCH scale, 2 <sup>nd</sup> Edition 1997 (ISBN 3-9520749-3-4)
eval.	evaluation after specified days after treatment
DAT	days after treatment
n	number of trials
GC	Ground Cover [% of ground]
n	"no"
y	"yes"

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digits underneath of product name means rate of a.i. applied [g of pure ai/ha].

Selectivity and herbicidal activity of Imazamox combinations pre-emergence in oilseed rape

(H / 2001 / 102 / VTH / 008, 011, 014 - Mobile Trial Unit, Germany)

PF 55487

Calculation on synergistic effects (Colby: $E(\text{expected value}) = X + Y - (X \cdot Y / 100)$ )			
Butisan+Raptor			
750+20	750+30	750+40	
E    Syn.	E    Syn.	E    Syn.	E    Syn.

winter rape	1.	3	7	0	0	0	0	0	0	0
	2.	3	69	0	0	0	0	0	0	0
	3.	3	54	0	0	0	0	0	0	0

Ø grasses		26	36	43	65	99	100	100	100
Alopecurus myosuroides	3. 1 1	25	35	42	62	99	100	100	100
Apera spica-venti	3. 1 3	27	37	43	68	99	100	100	100

broadleaf weeds		50 66 73 88 90 93 98 99											
Arabidopsis thaliana Capsella bursa-pastoris Galium aparine Geranium pusillum Lamium amplexicaule Matricaria inodora Sinapis alba Sisymbrium officinale Stellaria media Thlaspi arvense Veronica triphyllos	3.	1	2	32	40	47	82	96	99	97	99		
	3.	2	6	56	81	89	93	99	99	100	100		
	3.	1	1	30	72	82	89	96	96	98	100		
	3.	1	7	73	78	80	93	95	99	99	99		
	3.	2	2	73	79	84	94	98	100	100	100		
	3.	2	7	32	48	58	69	99	99	99	100		
	2.	2	3	78	81	90	93	53	92	94	97		
	3.	1	1	53	63	68	90	55	97	99	99		
	3.	3	3	49	67	75	90	99	100	99	100		
	3.	1	1	37	73	87	92	97	100	100	100		
	3.	1	2	33	40	47	87	98	99	97	100		

Raptor = 70 % imazamox, WG

Butisan = 500 g/l metazachlor, SC

1. Eval.: 7-19 DAT

2. Eval.: 67-68 DAT

3. Eval.: 202-206 DAT

Selectivity and herbicidal activity of Imazamox combinations at spiking in oilseed rape

(H / 2001 / 103 / VTH / 017, 018, 021 - Mobile Trial Unit, Germany)

rate in g a.i./ha	GS				eval.	n	GC	Raptor				Butisan S				Calculation on synergistic effects (Colby: E(expected value)= X+Y - (X*Y/100) Butisan+Raptor																							
												+ Raptor																											
												750				750+20				750+30				750+40															
								20	30	40	50	(1.5 l/ha)												E				Syn.				E				Syn.			
winter rape	10/12								1.	3	7	0	0	0	0	1	0	1	1	2																			
									2.	3	26	0	0	0	1	5	1	3	5	11																			
									3.	3	70	0	0	0	0	0	0	0	0	0	0																		
									4.	3	68	0	0	0	0	0	0	0	0	0	0																		

16

broadleafweeds													
		76	85	86	94	98	98	98	100	100	100	100	100
Capsella bursa-pastoris	--	86	93	96	97	98	98	98	97	100	100	99,92	y
Geranium pusillum	10/12	63	77	73	93	92	92	92	93	98	99	97,84	y
Sisymbrium officinale	--	65	73	70	90	99	99	99	99	100	99	99,7	n
Stellaria media	9/12	76	87	89	95	99	99	99	98	100	100	99,89	y
Veronica hederaefolia	9/10	77	87	89	94	99	99	99	99	100	100	99,89	y
Veronica persica	9/10	89	95	97	97	99	99	99	99	99	100	99,97	y

Raptor = 70 % imazamox, WG  
Butisan = 500 g/l metazachlor, SC

- 1. Eval.: 6-19 DAT
- 2. Eval.: 21-25 DAT
- 3. Eval.: 55-60 DAT
- 4. Eval.: 185-196 DAT

Selectivity and herbicidal activity of Imazamox combinations post-emergence in oilseed rape  
(H / 2001 / 104 / VTH / 028, 029 - Mobile Trial Unit, Germany)

rate in g a.i./ha		GS			Raptor*								Butisan S				Calculation on synergistic effects (Colby: E(expected value)= X+Y - (X*Y/100) Butisan+Raptor			
		eval.	n	GC	20	30	40	50	750 (1.5 l/ha)	750	+20	+30	+40	E	Syn.	E	Syn.	E	Syn.	
winter rape	12/14	1.	2	15	0	1	3	6	0	0	0	2	6	77,00	y	78,00	y	84,00	y	
		2.	2	25	1	4	7	12	0	3	5	8								
		3.	2	68	0	0	0	0	0	0	0	0								
		4.	1	37	0	0	0	0	0	0	0	0								
grasses					77	78	84	88	0	88	90	96								
Agropyron repens		11/13	4.	1	1	77	78	84	88	0	88	90	96							
broadleaf weeds					65	76	83	90	63	83	95	96								
Geranium pusillum		10/14	4.	1	6	68	77	85	90	48	72	91	95	83,36	n	88,04	y	92,20	y	
Rumex acetosella		--	4.	1	4	55	73	77	87	73	84	96	95	87,85	n	92,71	y	93,79	y	
Sisymbrium officinale		10/12	4.	1	1	73	78	87	92	68	93	97	97	91,36	y	92,96	y	95,84	y	

\* = + 1 l/ha Dash HC  
Raptor = 70 % imazamox, WG  
Butisan = 500 g/l metazachlor, SC

\*\* = + 5 kg/ha Ammonium-sulfate

1. Eval.: 7-8 DAT  
2. Eval.: 22 DAT  
3. Eval.: 48-49 DAT



Post emergent control of Setfaria faberi (solo herbicide application)

Product Name		AI Rate (g/ha)	Control
1	CHECK		0
2	BEYOND	10.0	50
3	BEYOND	20.0	63
4	BEYOND	40.0	85
5	BUTISAN S	188.0	0
6	BUTISAN S	375.0	0
7	BUTISAN S	750.0	0
8	OUTLOOK	630.0	0
9	DUAL II MAG- NUM	1070. 0	0



Post emergent control of Setfaria faberi (10 g/ha imazamox plus x g/ha co herbicide)

Product Name	AI Rate (g/ha)	Control
BEYOND BUTISAN S	<div>10.0</div> 188.0	94
BEYOND BUTISAN S	10.0 375.0	95
BEYOND BUTISAN S	10.0 750.0	93
BEYOND OUTLOOK	10.0 630.0	78
BEYOND DUAL II MAG- NUM	10.0 1070. 0	82

Post emergent control of Setfaria faberi (20 g/ha imazamox plus x g/ha co herbicide)

Product Name	AI Rate (g/ha)	Control
BEYOND BUTISAN S	20.0 188.0	92
BEYOND BUTISAN S	20.0 375.0	98
BEYOND BUTISAN S	20.0 750.0	99
BEYOND OUTLOOK	20.0 630.0	98
BEYOND DUAL II MAG- NUM	20.0 1070.0	98

Post emergent control of Setfaria faberi (40 g/ha imazamox plus x g/ha co herbicide)

Product Name	AI Rate (g/ha)	Control
BEYOND BUTISAN S	40.0 188.0	99
BEYOND BUTISAN S	40.0 375.0	99

Post emergent control of Avena fatura (herbicide solo application)

**AVEFA**

Product Name	AI Rate (g/ha)	Control
CHECK		0
BEYOND	10.0	30
BEYOND	20.0	30
BEYOND	40.0	38
BUTISAN S	188.0	33
BUTISAN S	375.0	32
BUTISAN S	750.0	30
OUTLOOK	630.0	23
DUAL II MAG- NUM	1070. 0	27

Post emergent control of Avena fatura (20 g/ha imazamox plus x g/ha co herbicide)

Product	AI	AVEFA
Name	Rate (g/ha)	Control
BEYOND	<del>20.0</del>	57
OUTLOOK	630.0	

Post emergent control of Avena fatura (40 g/ha imazamox plus x g/ha co herbicide)

Product	AI	AVEFA
Name	Rate (g/ha)	Control
BEYOND	<del>40.0</del>	91
BUTISAN S	188.0	
BEYOND	40.0	89
BUTISAN S	375.0	
BEYOND	40.0	95
BUTISAN S	750.0	
BEYOND	40.0	95
OUTLOOK	630.0	
BEYOND	40.0	82
DUAL II MAG-	1070.	
NUM	0	